30 Years of Photodissociation Regions:
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Water in PDRs: What the Observations Have to Say

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Current models of photodissociation regions, such as Hollenbach et al. 2009, predict that gas-phase water will exist mainly between at A_V's of about 3 and 8 mag. into dense molecular clouds, with the depth of the peak water abundance dependent upon the intensity of the FUV field and the gas density. At depths into the cloud greater than $A_V \sim 10$, these models predict that water will be predominantly locked in ice on grain mantles. This picture holds great appeal since it is consistent with, and would seem to explain, the low O_2 column densities and high water-ice column densities observed toward dense molecular clouds. However, these models are based on a competition between the rates of a number of physical processes, including photodissociation, photodesorption, grain-surface and gas-phase chemistry, and freeze out. At least two questions arise: (1) Are the assumed rates correct?; and, (2) Are there other unaccounted for processes?

To help answer these questions, we mapped a $25' \times 40'$ region toward the Orion Molecular Ridge, a face-on PDR and the largest velocity-resolved map made by the Herschel Space Observatory. Unlike our earlier study using data obtained with SWAS, and which contained 77 spatial positions (Melnick et al. 2011), the current study includes 2,220 o-H_2O 557 GHz and o-NH_3 572 GHz spectra acquired with Herschel along with fully-sampled maps of the same region in transitions of ^{12}CO, ^{13}CO, C^{18}O, HCN, CN, C_2H, and N_2H^+ obtained with FCRAO. Some of these species are predicted to have their peak abundance at A_V's < 10, such as HCN, CN, and C_2H, while others, such as ^{12}CO, ^{13}CO, C^{18}O, N_2H^+, and NH_3, absent freeze out, are expected to reach and retain their peak abundance at A_V's > 5 – i.e., throughout the well-shielded cloud. In this talk we show that the integrated intensity correlations among these species can be used to determine the distribution of gas-phase water within dense molecular clouds and their surface PDRs. In addition, we present the results of a complementary study – i.e., a strip scan made in o-H_2O, o-NH_3, and ^{13}CO across the edge-on PDR toward Cepheus B.

REFERENCES

Hollenbach, D., Kaufman, M.J., Bergin, E.A., and Melnick, G.J. (2009) ApJ, 690, 1497
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